Laser Interferometer Space Antenna
Mission update

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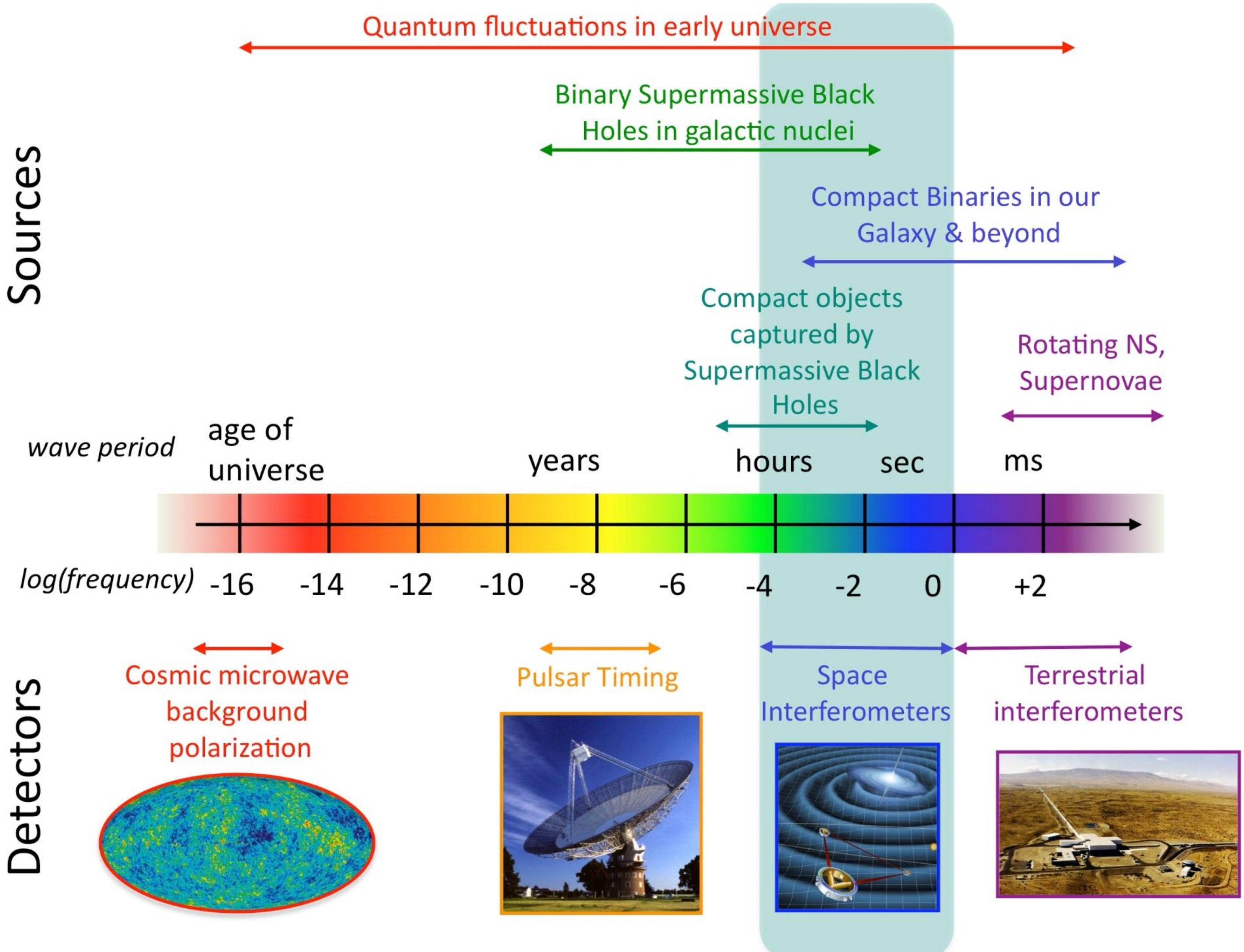
Thanks to Ira Thorpe, GSFC

The GW Spectrum



The Laser Interferometer Space Antenna

ESA-led with major NASA involvement

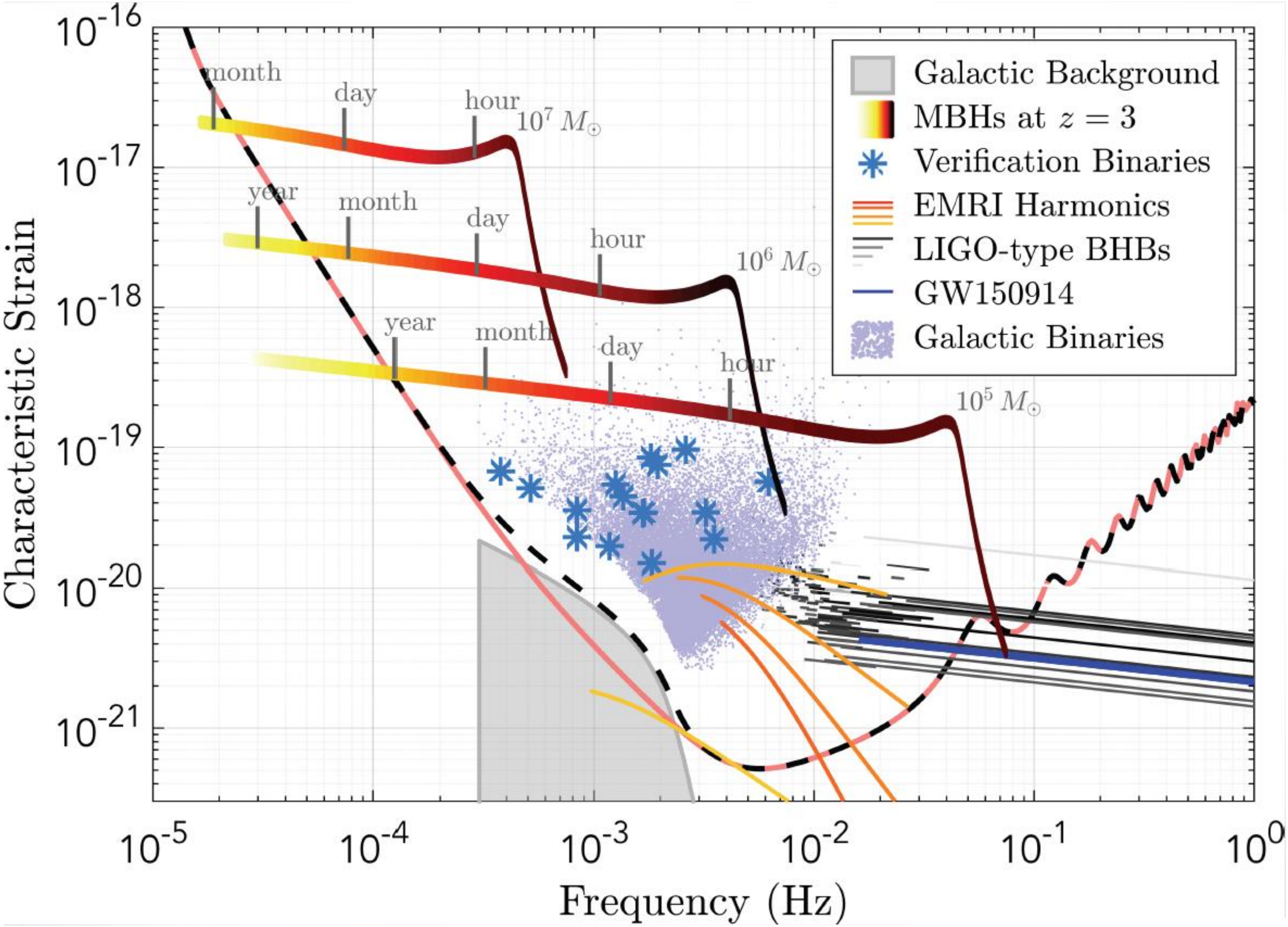
1st space-borne gravitational wave observatory

3 drag-free spacecraft

2.5 million km triangle in heliocentric orbit

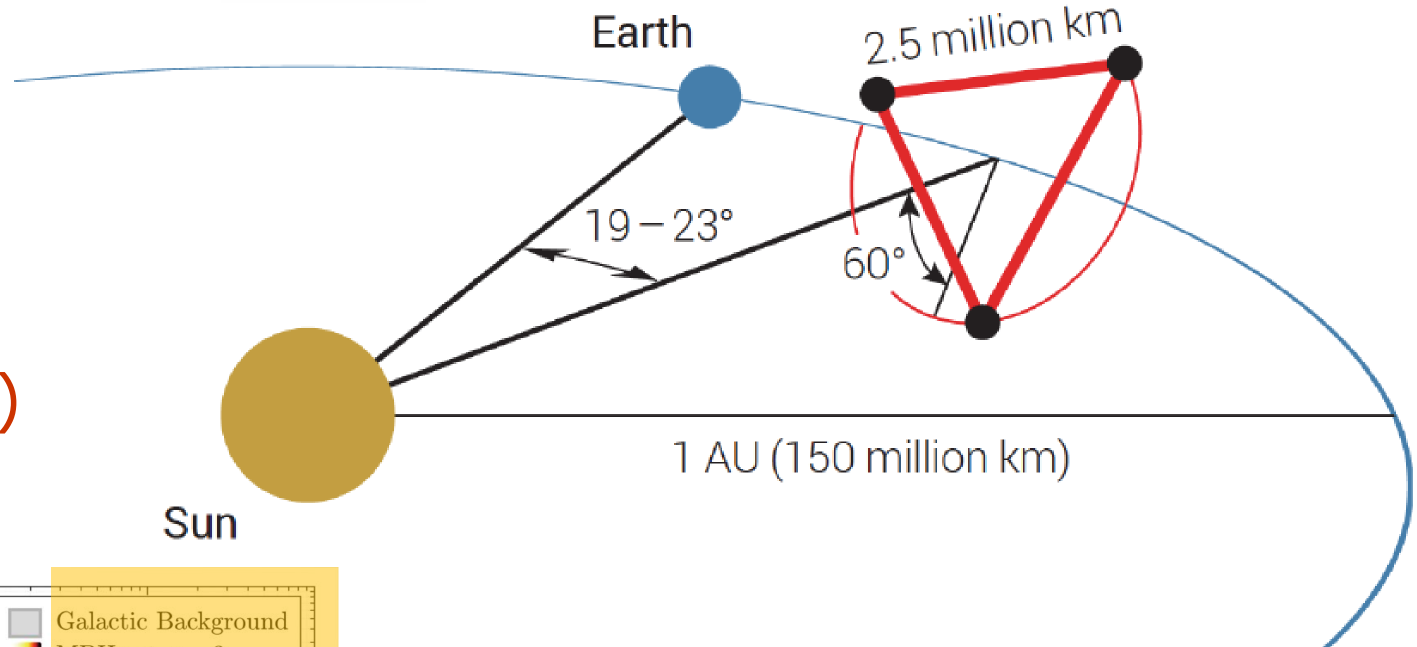
Launch: early 2030’s

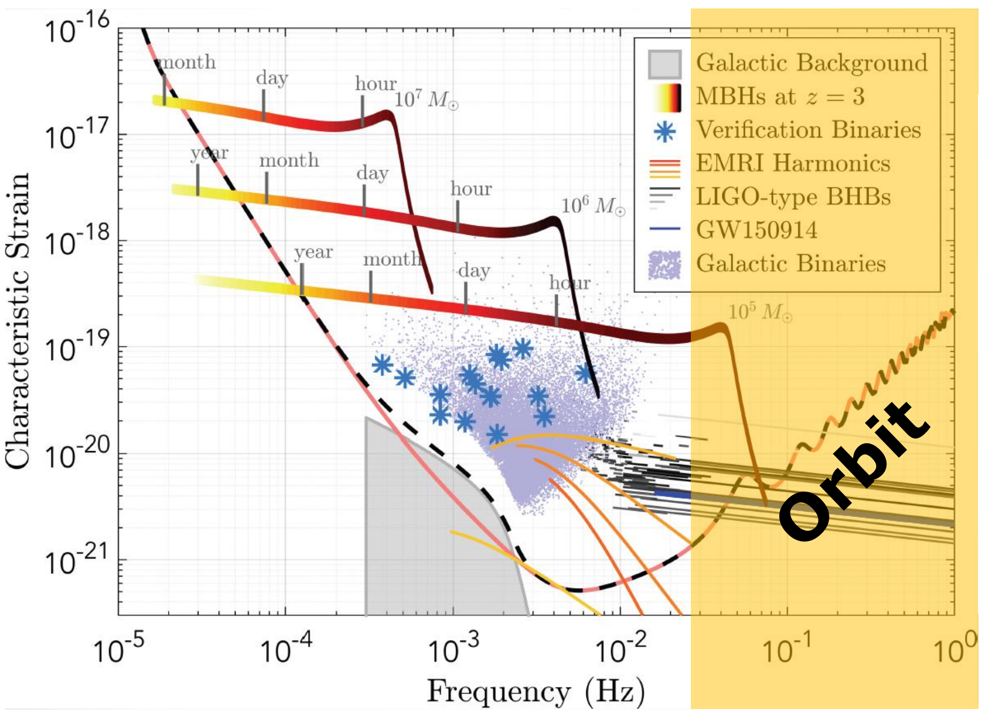
LISA Sensitivity Curve

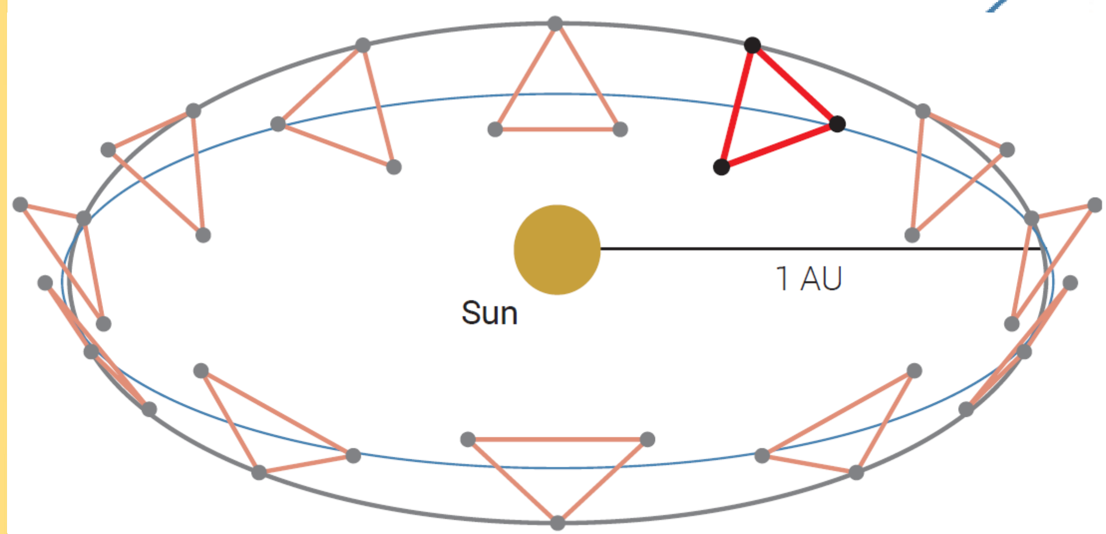


Strain Curve → Orbit

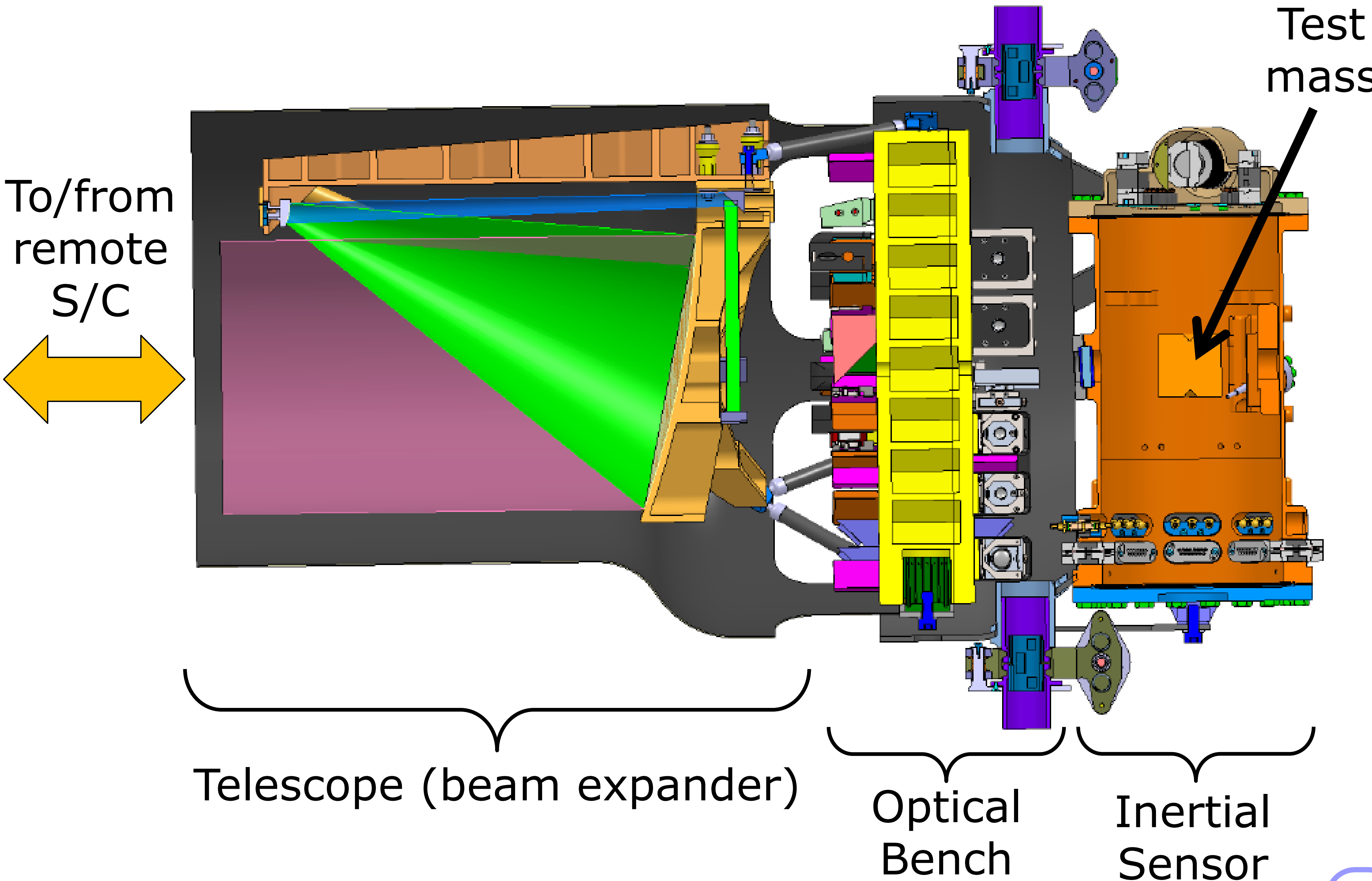
- 4 yr mission
  - 10 yr extension
- 3 arms
  (6 one-way links)





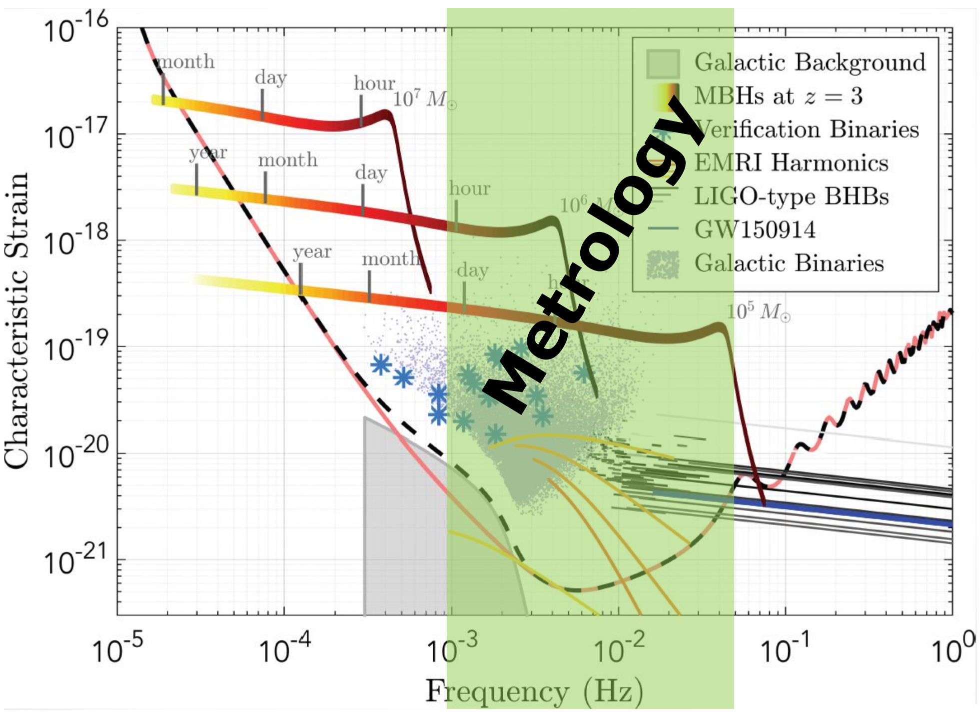


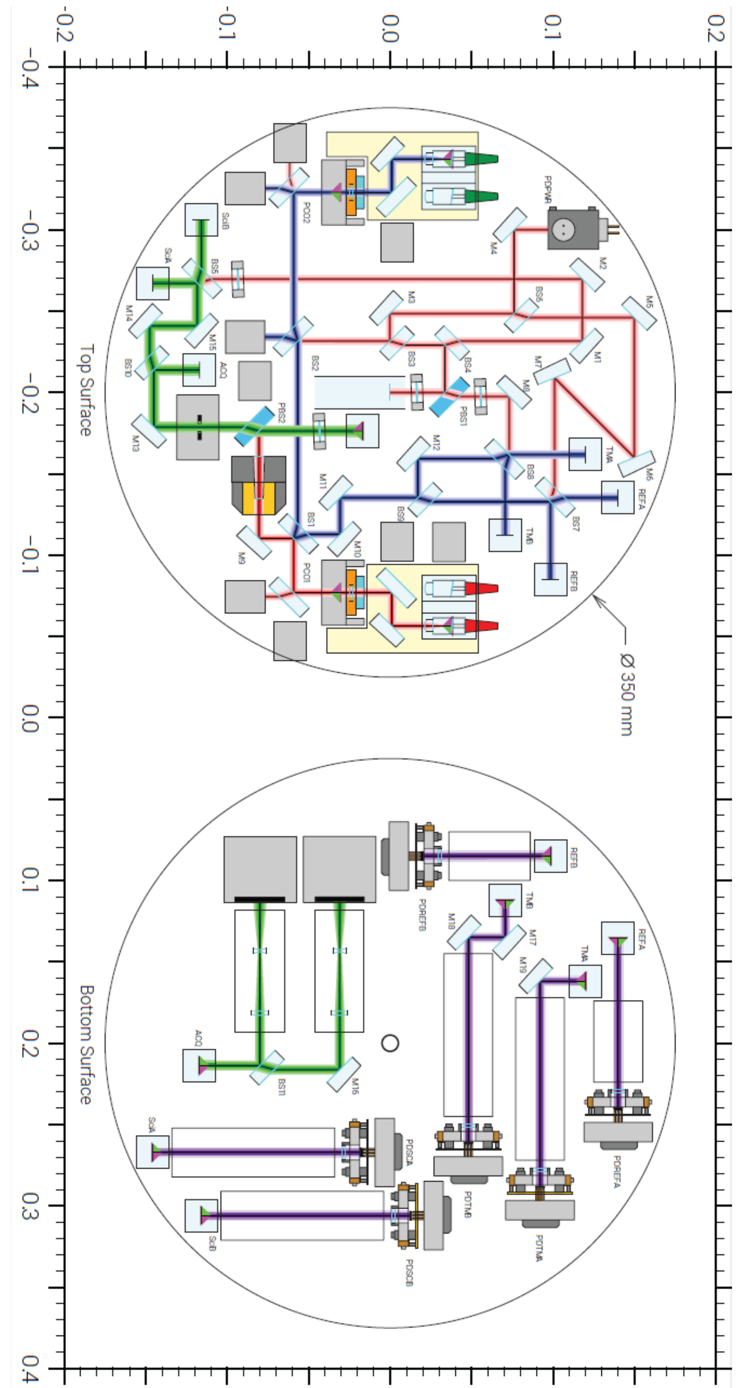
LISA Core Instrument



Strain Curve → Metrology

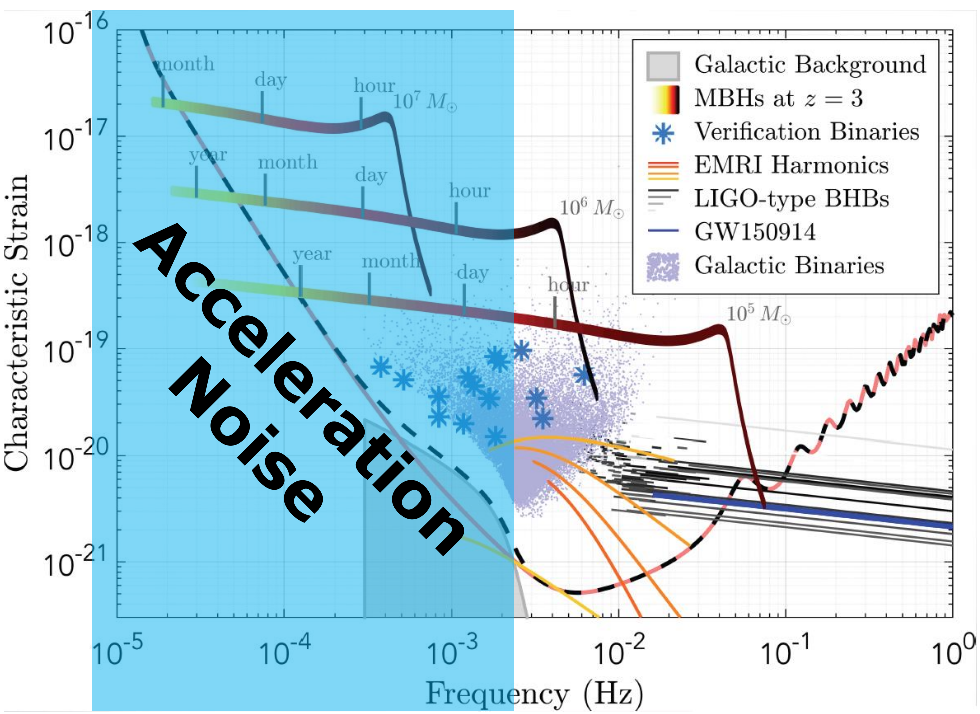
- 10 pm/Hz$^{1/2}$ one-way
  - 2 W, 1064 nm lasers with frequency stabilization
  - Low CTE optical benches with 4 interferometers
  - µcycle over MHz phasemeter
  - 30 cm telescopes





Strain Curve → Acceleration Noise

- Disturbance Reduction System
  - Inertial sensor with test masses, electrode housings, electronics, charge control, caging mechanism
  - Drag-free control using microthrusters
  - Quiet thermal, EM, gravitational environment with monitoring

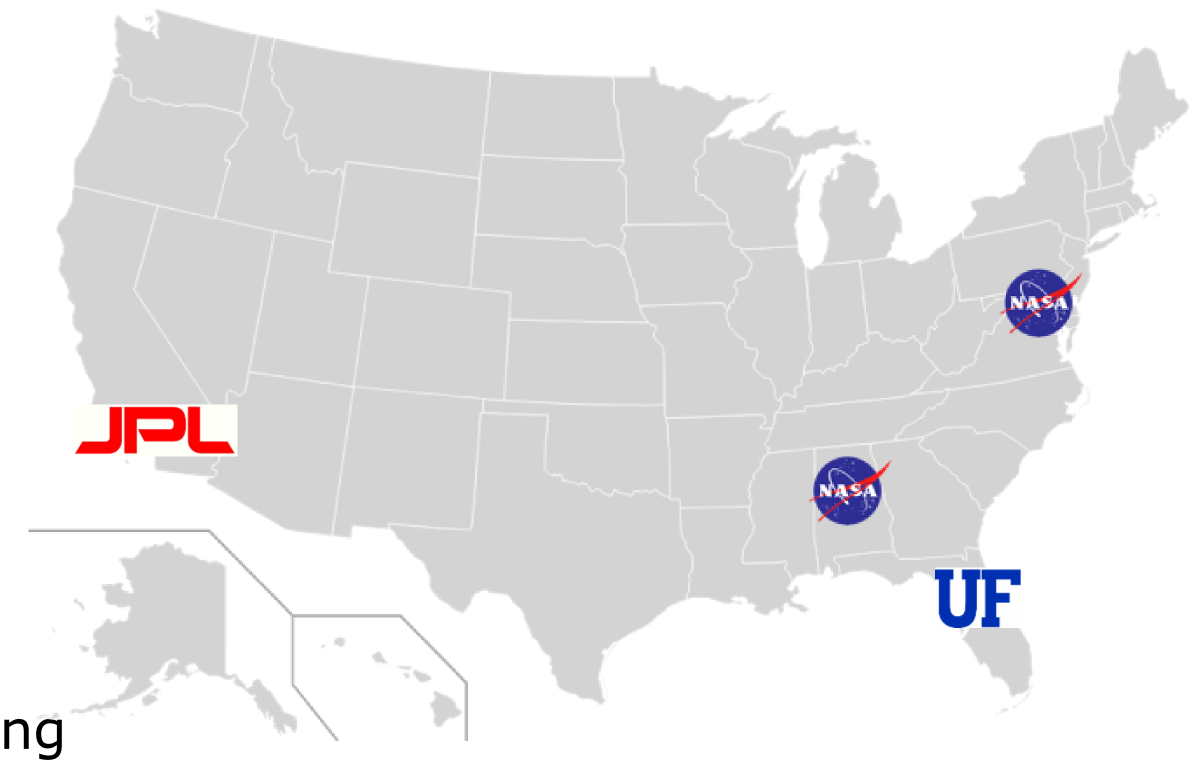


Top-level LISA Mission Organization

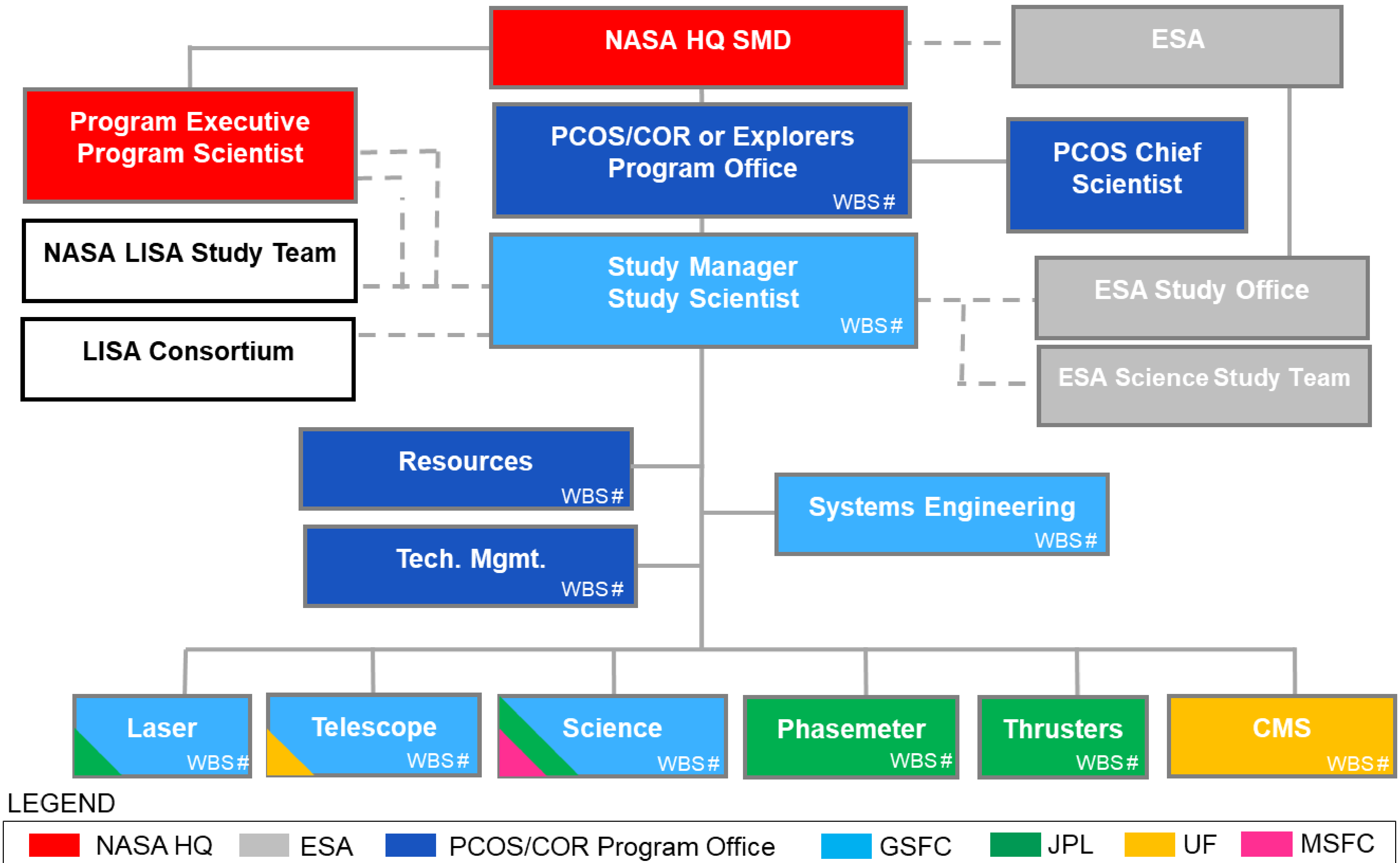
- Mission lead – European Space Agency
- Mission Industrial Prime
  - Competitive in Phase A (now); Down-select before Phase B (2020)
    - Airbus D & S, Germany
    - Thales Alenia Space, Italy
  - Possible NASA Contributions to LISA platform
- Science Instrument
  - LISA Consortium: Instrument lead
  - Airbus D & S: Instrument architect
  - European member state instrument contributions
  - NASA instrument contributions
- Science
  - LISA Consortium consisting of European and U.S. members

NASA LISA Study Office

- "proto-project"
  - Conducts pre-formulation activities w/o formal project structure
  - Will evolve into formal NASA Project Office
- Hosted by Physics of the Cosmos (PCOS) Program
  - Program responsible for science themes including GW
- Executed by NASA field centers, Academia
  - GSFC: management, science, sys. eng; telescope, laser
  - JPL: science, sys. eng. support; interferometry, micropropulsion
  - MSFC: science support
  - UF: CMS, telescope testing

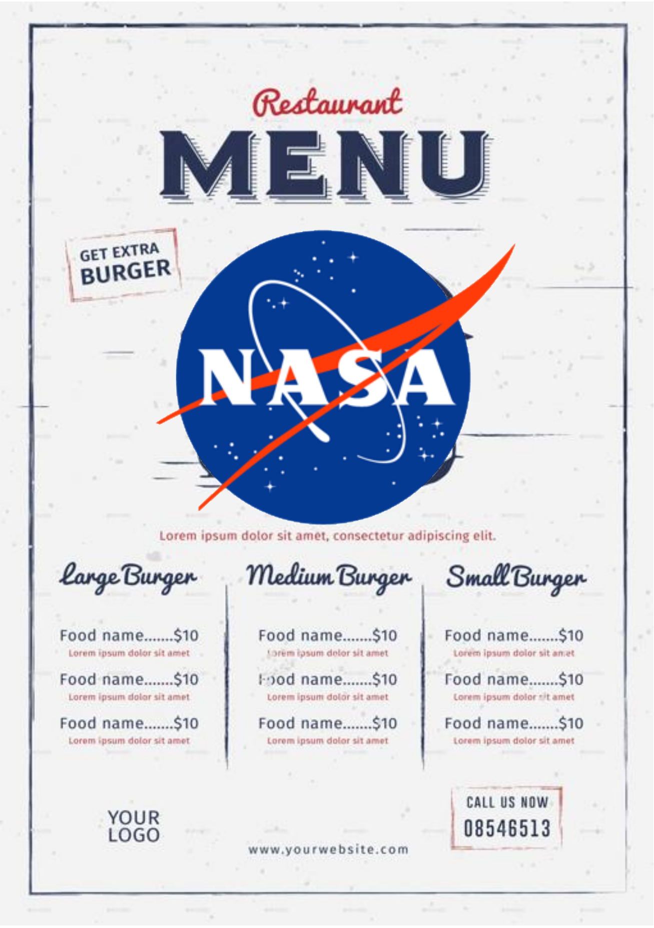


Organization Chart



Study Office Near-term Goals

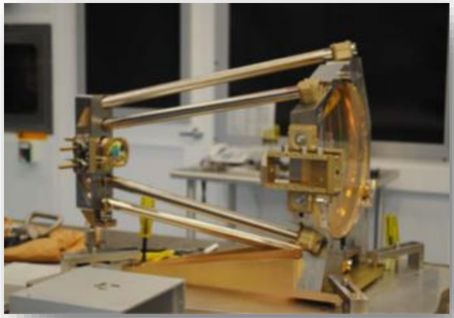
- Develop “menu” of possible NASA contributions
  - Payload systems and subelements (req. tech development)
  - Spacecraft components
  - Ground segment contributions
  - Operations contributions
  - Science support
  - …

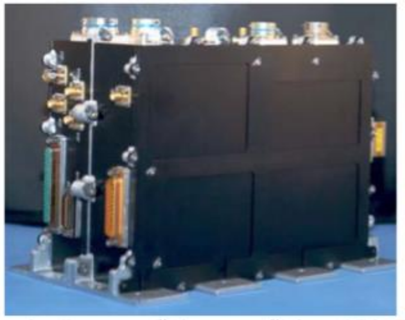


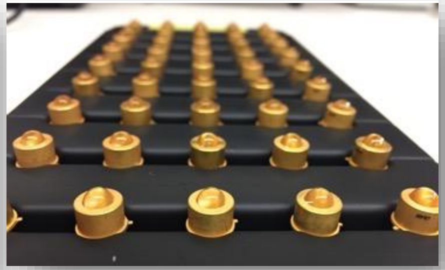
- Assess each contribution
  - Compatibility with partners/ease of interface
  - US interest
  - NASA capabilities
  - Cost
- Work with NASA HQ, ESA, Consortium to consolidate final roles and responsibilities

U.S. Technology Development

- Goal
  - Bring a handful of critical technologies to sufficient readiness prior to mission adoption (goal: TRL6 by 2022)
  - Demonstrate key driving requirements, reduce risk
- Investment strategy
  - US heritage/expertise
  - insight into the GW instrument
  - known and tractable interfaces
- Technologies
  - Stable Laser system (GSFC+JPL)
  - Telescope (GSFC+UF)
  - Phase measurement, interferometry processing (JPL)
  - Micropropulsion (JPL)
  - Charge management (U. Florida)







LISA & Astro2020

- LISA is part of the "program of record"
  - It is an ongoing activity with a baseline cost accounted for in NASA spending projections
- Astro2020 will still comment on LISA
  - From the Statement of task:

*"The study will **assess** whether **NASA's plans of** WFIRST, Athena, and **LISA** play an appropriate role in the research strategy for the next decade. The study may include findings and **recommendations regarding these plans**, as appropriate, **including substantive changes** to NASA's plans. Recommendations may include, but are not limited to, actions ranging from **increased investments (upscopes) to reduced investments (descopes) and termination**. It is **not necessary to rank** WFIRST, Athena, and **LISA** among other recommended activities for space"*

How NASA/Community is Preparing

- Science whitepapers
  - 11 organized by the NLST
  - Many others relate to LISA
- Develop Supporting Material
  (not submitted, available as reference, e.g. lisa.nasa.gov)
  - Overall Science Case
  - Technical Readiness
  - Analysis/Theory Readiness
  - LISA for Observers
  - FAQ, observer tool, graphics, etc.
- Response to queries from Astro2020
  - Present baseline plan
  - Assessment of NASA’s cost, risk, and science benefits
  - Comment on potential upscopes

LISA Mission Schedule

- Currently in Phase A
  - Competitive "System Prime" phase
  - Mission and instrument formulation
- Next milestones
  - Mission Consolidation Review – Summer 2019
  - Mission Formulation Review – Summer 2020 (Prime down-select)
- Major milestone: Mission Adoption – end of 2022
  - Mission design is "frozen"
  - Who is doing what is finalized
- Launch = Mission Adoption + 9.5 years = early 2030's
  - Cruise = 2 years
  - Nominal mission = 4 years
  - Extended mission = 10 years

“For Scientists” on lisa.nasa.gov

- Astro2020 WPs
- FAQ
- More coming soon!